Bottomland Hardwood Restoration In The Lower Mississippi River Alluvial Floodplain, United States

John A. Stanturf
US Forest Service, Southern Hardwoods Laboratory, P.O. Box 227
Stoneville, Mississippi 38776

James P. Shepard
National Council for Air and Stream Improvement, Southern Technical Center, P.O. Box 141020, Gainesville, Florida 32614

Introduction

Forested wetlands in the southern United States occur mostly in the floodplains of major rivers and their tributaries, within a broad coastal plain stretching from Texas to Virginia. Two thirds of the annual losses of wetlands in the conterminous United States occur in forested wetlands, primarily in the South (Wilen and Frayer 1990). There are almost 31 million acres of forested wetlands in the South, comprising less than one-third of their extent prior to European settlement. While the loss of wetlands continues, the rate of loss has slowed. Nevertheless, only 5 million acres of forested wetlands remain in the floodplain of the Lower Mississippi River, of an estimated 21 to 23 million acres prior to 1780 (MacDonald et al. 1979; Turner et al. 1981; The Nature Conservancy 1992). Forested wetland losses in other parts of the South are just as striking (Tansey and Cost 1990; Hefner and Dahl 1993).

The LMAV once supported the largest expanse of forested wetlands in the United States. Rich alluvial soils of the Delta received periodic sediment additions from the world's third largest river, and supported highly productive ecosystems (Harris and Gosselink 1990). The importance of these ecosystems as vital wildlife habitat for both resident and migratory species has been documented (Wharton et al. 1982).

Restoration Programs

The loss of botomlands hardwood (BLH) forests in the LMAV has been mostly due to conversion to agriculture, as much as 96% (MacDonald et al. 1979; Department of the Interior 1988). Massive flood control projects began after devastating floods in 1912, 1913, 1916, 1927, and 1929 (The Nature Conservancy 1992). Major levees were constructed along the Mississippi and its tributaries, and an extensive drainage system developed to support farming. Additional wetland losses have been due to construction of navigational structures, continuing flood control measures, surface mining, and urban development.

A surge in forest clearing for agriculture took place in the 1960s and 1970s, in response to a rise in soybean prices. Privately-owned forestland was cleared and planted to row crops. When prices eventually fell, land that was marginal for agriculture because it was still subject to spring and early summer backwater flooding became idle. Since 1980, public and private programs have supported restoration of former cropland to bottomland hardwood forests.

Public Programs

The Conservation Reserve Program (CRP) began in 1980 to subsidize establishment of permanent vegetative cover on erodible cropland, and often included converted wetlands. By the ninth enrollment year (1989), almost 50,000 acres of wetlands in the LMAV were placed into the CRP (The Nature Conservancy 1992).

The Wetland Reserve Program (WRP) was included in the 1990 Farm Bill and set a maximum signup of 1 million acres nationwide. A pilot program was funded in 1992, in eight states. Two states in the LMAV, Louisiana and Mississippi, were included. More acres were submitted in these states than could be accepted into the WRP because of financial limitations.

In 1987, the United States Fish and Wildlife Service began an aggressive program in the LMAV to restore bottomland hardwood ecosystems (Haynes et al. 1993). This effort was not limited to existing wildlife refuges; most of the effort has gone into reforestation of private lands and foreclosed farmland transferred to the Service from the Farmers Home Administration. To date, they have planted or contracted for planting over 30,000 acres in the South. They anticipate planting an additional 20,000 acres through 1998, mostly within the LMAV.

State agencies have undertaken ambitious restoration projects as well. Over 4900 acres near Monroe, Louisiana are being restored by the Louisiana Department of Wildlife and Fisheries (Savage 1989; Newling 1990). The Mississippi Department of Wildlife, Fisheries and Parks is restoring 1000 acres near Greenwood, MS (Newling 1990).

The Corps of Engineers is restoring bottomland hardwood forests in order to mitigate fish and wildlife habitat losses induced by flood control construction. One ambitious mitigation project is the Lake George property in the Yazoo River Basin, MS (Corps of Engineers 1989). The tract is on 8800 acres of frequently flooded agricultural land near Rolling Fork, MS. Reforesting began in 1991, and will continue into 1996. The goal is to connect Panther Swamp National Wildlife Refuge with Delta National Forest by a forested corridor.

Private Efforts

Early private efforts centered on hardwood plantations for producing fiber. One outstanding example is the Fitler Managed Forest near Onward, MS. This 10,000 acre cottonwood (*Populus deltoides* Bartr. ex Marsh. var. *deltoides*) forest is owned by James River Timber Corp. and intensively managed for pulpwood production. Recent private efforts have concentrated on reforestation primarily for creation of wildlife habitat and for timber. Baxter Land Company, a large farming operation in Desha and Chicot Counties, Arkansas, recently planted 350 acres of cottonwood on low-lying cropland. Their objectives were erosion control, financial return from timber, and increased wildlife habitat (Anon. 1994).

Techniques for Restoration

Techniques for establishing bottomland hardwoods include direct-seeding and planting seedlings. If good quality seedlings are planted properly and cared for well prior to planting, the chances for successful establishment are high (Kennedy 1984; Kennedy et al. 1987; Allen and Kennedy 1989; Kennedy 1994).

Direct-seeding has only proven successful for oaks and other large seeded species. Nuttall oak (*Quercus nuttalli* Palmer) has been the most reliable species, and greater success has been obtained with the red oak group as compared to the white oaks (Johnson and Krinard 1987). Almost all attempts at direct-seeding light seeded species (*Fraxinus, Liquidambar, and Ulmus*) have failed (Allen et al. In Press). Failures have been attributed to drought stress shortly after germination, or to bird and rodent predation.

Another advantage of planting seedlings is that a wider range of sites and conditions can be tolerated. While extended post-planting flooding damages most seedlings, the taller planted seedlings may extend above floodwaters and survive. On the other hand, there is a narrower planting window in the South for planting seedlings (December to April). Direct-seeding offers a wider planting window, as studies have shown that acorns can be planted year-around. Weather conditions following sowing, however, can be critical to survival. The best times for direct-seeding are fall through spring (Johnson and Krinard 1987; Wittwer 1991).

The main advantage of direct-seeding is potentially lower costs (Kennedy 1994) by avoiding the costs of growing and handling seedlings, and acorns are less time-consuming to plant than seedlings. The major disadvantages of direct-seeding are that the plants are in more vulnerable stages of development longer, thus risking poor survival and possible failure. Competing vegetation may pose more of a threat to new germinants, as many oaks are slow to develop above-ground and can be overtopped by competitors.

Direct-seeding and planting seedlings can both be accomplished by hand using very simple and inexpensive equipment. On formerly forested sites, hand planting or sowing are preferred as intensive site preparation is not required. Planting or sowing by hand is easy to do properly, and all too easy to do improperly. Seedlings should be planted deeply enough that the root collar is just below the soil surface. Large seeds such as acorns should be sown between 2 to 6 inches deep.

Mechanical planting and sowing are significantly faster on clean sites with slopes less than 10%. Modified agricultural planters have been used successfully for direct-seeding, although some new equipment has been developed for acorns. A broadcast seeder has been used in trials in Louisiana (Allen et al. In Press). Aerial seeding has been shown in small trials to have potential, although more work needs to be done to optimize the delivery system and the method of burying acorns after sowing (Allen et al. In Press).

Current Research

While the literature on bottomland hardwood restoration is substantial (Haynes et al. 1988), much needs to done (Clewell and Lea 1990; Sharitz 1992). Major research emphasis today is on characterizing reference sites to guide restoration efforts; new reforestation techniques, such as intercropping; methods to establish mixed species stands; and on the effects of restoration at the landscape level.

Reference Sites

Sharitz (1992) stressed the need to compare functions of natural and restored forests, as we have not established that reforesting restores all functions. A first step in achieving restoration is to identify the functions that characterize undisturbed sites. These undisturbed sites must be identified and characterized in order to develop criteria for measuring the success of restoration projects.

An interdisciplinary team of researchers from several federal agencies and universities are cooperating in an integrated regional project to study the structure and function of bottomland hardwood forests in the southern United States (Harms and Stanturf 1994). The objectives of this project are (1) to quantify the physical, chemical and biological functions of these forested wetlands, and (2) to document and evaluate the effects of silvicultural manipulation on key functions.

Four sites have been selected and gathering of baseline data has begun. Results from this study should provide the understanding of functions of bottomland hardwood forests needed to guide restoration efforts and allow for evaluation of their success.

Intercropping

The forest products industry, the Fish and Wildlife Service, and the Forest Service Southern Hardwoods Laboratory are implementing a large-scale study of reforestation techniques. Four treatments will be compared that differ in intensity, in rapidity of reforestation, and in future opportunities for income from timber. Treatments consist of direct seeding Nuttall oak acorns, planting Nuttall oak seedlings, intercropping cottonwood with Nuttall oak, and a control treatment that will be allowed to revegetate naturally. Each treatment will be evaluated using 20-acre plots in three replicate blocks. These relatively large plots will be valuable for demonstration purposes and will be large enough to accommodate future research needs; for example, to compare wildlife use among treatments.

Intercropping cottonwood with Nuttall oak is a technique designed by James River Timber Corporation, who is already using it in its private landowner reforestation assistance program. The rationale for this novel technique is to use cottonwood as a nurse crop that improves the conditions for oak survival and growth. This treatment was explicitly designed to provide early income from timber as an economic incentive to encourage private landowners to reforest these degraded wetlands. The nurse crop concept is well-known in silviculture (Matthews 1989) and has been recommended for reforestation of abandoned agricultural fields (McKevlin 1992). However, no data are available to compare it to other more commonly used reforestation methods.

Cottonwood cuttings will be planted at12 by 12 foot spacing, with herbicide application and disking during the first two growing seasons to control competition. In the spring before the third growing season, Nuttall oak seedlings will be planted in between every other row of cottonwood.

Cottonwood can grow 65 feet in height and yield 30 cords per acre at age 10 on the heavy clay Sharkey soil typical of millions of acres of the Delta (Krinard and Kennedy 1983a, b). Yields for other species we considered as a nurse crop were lower than for cottonwood. Green ash (*Fraxinus pennsylvanica* Marsh.) at age 10 on Sharkey soils has been shown to range from 27 ft to 30 ft, sweetgum (*Liquidambar styraciflua* L.) ranged from 18 ft to 21 ft, and sycamore (*Platanus occidentalis* L.) from 26 ft to 31 ft (Krinard and Kennedy 1983b). Thus, cottonwood growth is approximately double that of other species. Volume growth followed similar trends.

At age 10, the cottonwood will be harvested and the oak released. If the cottonwood is harvested in the dormant season, sprouting will occur and a second, 10-year pulpwood rotation can be obtained. Previous research indicates that the yields in the second rotation will be lower, however, than the first rotation. After the second cottonwood rotation is harvested, the 18-year-old oak forest can be released. Alternatively, selected cottonwood stems can be retained after either, or both, cottonwood harvests to increase diversity and structure in the stand. The rapid establishment of a forest canopy by cottonwood may accelerate natural succession by attracting the birds and small mammals that are vectors for dispersal of heavy seeds. Cottonwood may also be used to more rapidly create vertical structure, cavities for nesting, and downed woody debris than other reforestation techniques.

Mixed Species Stands

A major research challenge today is restoring mixed stands that quickly acquire the kind of structure found in natural stands. Restoration efforts in the past have concentrated on establishing single-species plantations. The appearance of a plantation can be avoided by altering the pattern of planting, for example by planting in wavy lines rather than straight rows. Other modifications will be necessary to establish stands with a canopy structure that maximizes avian diversity (Stanturf In press).

Multispecies plantations can be established in several types of mixtures (Goelz in press). Intercropping mixtures (single species rows) and mixed monotypes (species in block plantings) produce an overall mixture, but species are clumped in a way that does not mimic natural conditions.

Methods for establishing true mixtures will require basic information on how species compete with each other during early stand development, especially after crown closure. This line of research is illustrated by a systematic spacing study at Lake George, MS (Goelz 1991). This rather complicated study is looking at two spacings between individual stems (6ft and 9 ft), the proportions of green ash, Nuttall oak, and water oak (*Q. nigra* L.), and the relationship between size, distance, and species of neighbor on individual tree growth. Because early growth of some species can be quite slow, they can be overtopped by competitors. In addition to inherent growth rates, competitive ability is affected by environmental conditions such as soil properties and flooding frequency and duration (McKnight et al. 1981). Therefore, the Lake George spacing study is replicated on two contrasting soil types.

Landscape pattern

Most reforestation work occurs in small patches, except for a few large public projects. Many researchers have discussed the effects of fragmentation on wildlife, particularly area-sensitive, interior-dwelling neotropical migratory birds (Robbins et al. 1989; Wilcove and Robinson 1990). Few, however, have examined the benefits of reforesting in large blocks, particularly when existing large patches are to be connected by corridors. The Lake George Restoration site provides an opportunity to evaluate this hypothesis. The restoration site connects two of the largest blocks of natural and restored bottomland hardwood forests in the LMAV, and wildlife use of the area prior to, and following, restoration is being evaluated.

Summary

The focus of research on southern bottomland hardwoods has shifted, from documenting their loss to ways they can be restored. Many opportunities today exist to restore bottomland hardwood forests on economically marginal farmland. Public and private efforts have already restored over 30,000 acres in the Lower Mississippi Alluvial Valley.

Techniques for planting and direct-seeding bottomland hardwoods are available. Direct-seeding, although less expensive than planting seedlings, is limited to oaks and other heavy-seeded species. Direct-seeding and planting seedlings can be accomplished by hand, using very simple and inexpensive tools. Methods for mechanical planting and sowing are faster, but generally require more expensive preparation of the planting site. Efforts are underway to develop aerial seeding methods.

Current research on restoration of bottomland hardwood forests emphasizes more than just reforestation techniques. Restoration of mixed species stands is a major research challenge. A novel technique utilizing cottonwood as a nurse crop to red oak has the potential to provide a substantial economic incentive for private landowners to undertake their own restoration effort. Other advantages of the rapid establishment of a forest canopy include accelerated natural succession and improved wildlife habitat. Although most research concentrates on restoration at the site level, opportunities for examining the landscape level effects of restoration are increasing.

Literature Cited

Allen, J.A. and Kennedy, H.E., Jr. 1989. Bottomland hardwood restoration in the Lower Mississippi Valley. U.S. Fish and Wildlife Service and U.S. Forest Service. 28 pp.

Allen, J.A., Kennedy, H.E., Jr., and Clethre, A. In press.

Bottomland hardwood restoration manual. National Biological Survey, Lafayette, LA and U.S. Department of Agriculture, Forest Service, New Orleans, LA.

Anon. 1994. If at first you don't succeed. The Plantation, Fall 1994. Fitler Managed Forest, James River Timber Corporation, Rolling Fork, MS.

Clewell, A.F. and Lea, R. 1990. Creation and restoration of forested wetland vegetation in the southeastern United States. P. 195-231 in Kuslar, J.A. and Kentula, M.E. (editors), Wetland creation and restoration: The status of the science. Island Press, Washington, D.C. 591 pp.

Corps of Engineers. 1989. Yazoo backwater area mitigation lands, Lake George property land acquisition, Yazoo Basin, Mississippi: Environmental assessment. US Army Corps of Engineers, Vicksburg District, Vicksburg, MS. 20 pp.

Department of Interior. 1988. The impact of federal programs on wetlands. Vol.I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region. A Report to Congress by the Secretary of the Interior, Washington, D.C. 114 pp.

Goelz, J.C.G. 1991. Development of mixed-species hardwood plantations on two Mississippi Delta soil types. Study Plan FS-SO-4104-99, U.S. Department of Agriculture, Forest Service, Southern Hardwoods Laboratory, Stoneville, MS.

Goelz, J.C.G. In press. Experimental designs for mixed-species plantations. Paper presented at the Eighth Biennial Southern Silvicultural Research Conference, 1-2 November 1994, Auburn, AL.

Harms, W.R. and Stanturf, J.A. 1994. A quantitative assessment of the structure and functions of forested wetlands in bottomland hardwood ecosystems in the southern United States. Study Plan FS-SE-4103-207 and FS-SO-4152-110, U.S. Department of Agriculture, Forest Service, Center for Forested Wetlands Research, Charleston, S.C. and Southern Hardwoods Laboratory, Stoneville, MS.

Harris, L.D. and Gosselink, J.G. 1990. Cumulative impacts of bottomland hardwood conversion on wildlife, hydrology, and water quality. P. 259-322 in Gosselink, J.G., Lee, L.C. and Muir, T.A. (editors), Ecological processes and cumulative impacts: Illustrated by bottomland hardwood wetland ecosystems. Lewis Publishers, Inc. Chelsea, MI.

Haynes, R.J., Allen, J.A., Pendleton, E.C., and Grau, G.A. 1988. Reestablishment of bottomland hardwood forests on disturbed sites: An annotated bibliography. U.S. Department of the Interior, Fish and Wildlife Service Biol. Rept. 88(42). 104 pp.

Haynes, R.J., Bridges, R.J., Gard, S.W., Wilkins, T.M., and Cooke, H.R., Jr. In Press. Bottomland forest reestablishment efforts of the U.S. Fish and Wildlife Service: Southeast Region. In Proc. Wetlands Engineering Workshop, 3-5 August 1993, St. Louis, MO. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Hefner, J.M. and Dahl, T.E. 1993. Current forested wetland systems in the Southeast Region. U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA.

Johnson, R.L. and Krinard, R.M. 1985. Regeneration of oaks by direct seeding. In: Proc. Third Symp. of Southeastern Hardwoods. U.S. Department of Agriculture, Forest Service, Southern Region, Atlanta, GA.

Kennedy, H.E., Jr. 1984. Hardwood growth and foliar nutrient concentration is best in clean cultivation treatments. Forest Ecology and Management 8:117-126.

Kennedy, H.E., Jr. 1994. Artificial regeneration of bottomland oaks. P. 241-249 in Loftis, D.L. and McGee, C.E. (editors), Oak Regeneration: Serious problems, practical recommendations. Symposium proceedings; 1992 September 8-10; Knoxville, TN. Gen. Tech. Rep. SE-84. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station.

Kennedy, H.E., Jr., Krinard, R.M., and Schlaegel, B.E. 1987. Growth and development of four oaks through age 10 planted at five spacings in a minor stream bottom. In: Proc. 9th Annual Southern Forest Biomass Workshop, Mississippi State University, Mississippi State, MS.

Krinard, R.M. and Kennedy, H.E., Jr. 1983a. Growth, thinning treatments, and soil properties in a 10-year-old cottonwood plantation on a clay site. Research Note SO-302, U.S. Department of Agriculture, Forest Service, New Orleans, LA.

Krinard, R.M. and Kennedy, H.E., Jr. 1983b. Ten-year growth of five planted hardwood species with mechanical weed control on Sharkey soil. Research Note SO-303, U.S. Department of Agriculture, Forest Service, New Orleans, LA.

Matthews, John D. 1989. Silvicultural systems. Oxford University Press, New York. 284 p.

MacDonald, P.O., Frayer, W.E. and Clauser, J.K. 1979. Documentation, chronology, and future projections of bottomland hardwood habitat losses in the Lower Mississippi Alluvial Plain. Vols. 1 and 2, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

McKevlin, M.R. 1992. Guide to regeneration of bottomland hardwoods. General Technical Report SE-76, U.S. Department of Agriculture, Forest Service, Asheville, NC. 35 p.

McKnight, J.S., Hook, D.D., Langdon, O.G., and Johnson, R.L. 1981. Flood tolerance and related characteristics of trees of the bottomland hardwood forests of the southern United States. P. 26-69 in Clark, J.R. and Benforado, J. (editors), Wetlands of bottomland hardwood forests. Elsevier Scientific Publishers, New York.

Newling, C.J. 1990. Restoration of the bottomland hardwood forests in the Lower Mississippi Valley. Restoration and Management Notes 8(1): 23-28.

Robbins, C.S., Dawson, D.K., Dowell, B.A. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic states. Wildlife Monographs no. 103. 33 pp.

Savage, L., Pritchett, D.W., and DePoe, C.E. 1989. Reforestation of a cleared bottomland hardwood area in northeast Louisiana. Restoration and Management Notes 7(2):88.

Sharitz, R. 1992. Bottomland hardwood wetland restoration in the Mississippi drainage. P. 496-505. In: *Restoration of aquatic ecosystems: Science, technology, and public policy.* National Academy Press, Washington, D.C.

Stanturf, J.A. In press. Plantation establishment to restore bottomland hardwood wetlands: Past and future research at the Southern Hardwoods Laboratory. In. Proc. Wetlands Engineering Workshop, 3-5 August 1993, St. Louis, MO. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Tansey, J.B. and Cost, N.D. 1990. Estimating the forested wetland resource in the southeastern United States with forest survey data. Forest Ecology and Management 33/34:193-213.

The Nature Conservancy. 1992. Restoration of the Mississippi River Alluvial Plain as a functional ecosystem. The Nature Conservancy, Baton Rouge, LA. 53 pp.

Turner, R.E., Forsythe, S.W. and Craig, N.J. 1981. Bottomland hardwood forestland resources of the southeastern United States. In: Clark, J.R. and Benforado, J. (editors), Wetlands of bottomland hardwood forests. Elsevier Scientific Publishers, New York.

Wharton, C.H., Kitchen, W.M., Pendleton, E.C. and Sipe, T.W. 1982. Ecology of bottomland hardwood swamps of the southeast: A community profile. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program: FWS/OBS-81/37, Washington, D.C. 134 pp.

Wilcove, D.S. and Robinson, S.K. 1990. The impact of forest fragmentation on bird communities in Eastern North America. P. 319-331 in Keast, A. (editor) Biogeography and ecology of forest bird communities. SPB Academic Publishing, The Hague, The Netherlands.

Wilen, B.O. and Frayer, W.E. 1990. Status and trends of U.S. wetlands and deepwater habitats. Forest Ecology and Management 33/34:181-192.

❖

Sustainable Society and Protected Areas

Contributed Papers of the 8th Conference on Research and Resource Management in Parks and on Public Lands

April 17–21, 1995
Portland, Oregon

Edited by Robert M. Linn

Sponsored by
The George Wright Society

Co-Sponsored by: U.S. National Park Service • U.S. National Biological Service • National Oceanic and Atmospheric Administration, Coastal Ocean Office • U.S. Fish and Wildlife Service • National Park Foundation • Bureau of Land Management, Oregon-Washington State Office • Fort Clatsop Historical Association • Eastern National Park & Monument Association • Richard A. Brichetto and Sherry Wright Brichetto • Northwest Interpretive Association

Cooperating Organizations: Advanced Data Concepts, Inc. • Bonneville Power Administration • Columbia River Gorge Commission • The Museum at Warm Springs • Oregon Historical Society • Oregon State University • Portland Parks & Recreation Department • USDA-Forest Service

The George Wright Society
Hancock, Michigan
1995